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CONDITIONS AFFECTING THE VALUE OF MARKET HAY.

BY

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U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., March 26, 1909.

SIR: I have the honor to present herewith a paper entitled "Conditions Affecting the Value of Market Hay," prepared by Mr. Harry B. McClure, Scientific Assistant in the Office of Farm Management, Bureau of Plant Industry, and recommend that it be published as a Farmers' Bulletin.

This paper was prepared from an address delivered before the Fifteenth Annual Convention of the National Hay Association, at Cedar Point, Ohio, July 28–30, 1908, at which meeting resolutions were passed asking that it be published as a bulletin of the Department and distributed among hay producers and feeders.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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CONDITIONS AFFECTING THE VALUE OF MARKET HAY.

FACTORS INFLUENCING THE HAY INDUSTRY.

At the present time there is considerable confusion and misunderstanding regarding the value of the different kinds and grades of market hay. The producer many times does not know what the market requires in regard to purity, or freedom from volunteer grasses, weeds, etc., and quality, which depends on methods of cutting, curing, and baling. The average feeder often thinks that one kind of hay will answer all feeding purposes and pays a very high price for this kind; consequently, when other kinds which may be more valuable than the standard market hay are sent to the market, they sell at a price which is not very profitable to the producer. This is because the feeder's ideas concerning the feeding value of certain kinds of hay are erroneous. As a result of these misunderstandings both feeder and producer lose money. In order that all concerned in the hay industry, namely, producer, shipper, receiver, and feeder, may each receive his share of profit from the growing, handling, or feeding of hay, it is necessary that they work together in harmony for their mutual benefit. In order to do this and place the hay business on a better foundation, the following points are important:

(1) A better knowledge by the feeder of the feeding value of the different kinds and grades of market hay would be of decided advantage to both feeder and producer. The feeding value of any kind of hay should depend primarily upon the purpose for which it is fed.

(2) Producers in general must realize that it is the feeder who makes the price of hay, and in order to secure the most profit his demands in regard to quality must be met regardless of the producer's opinion. This difference of opinion may be illustrated by the fact that in many sections timothy cut at the end of or even after the blooming period is preferred for feeding on the farm, while the city feeder prefers that which is cut nearer the beginning of the blooming period, and will pay a higher price for this kind.

(3) Growing hay for the market is profitable only when the better grades are secured and when the loss of fertility is no greater than it is in other systems of farming, such as live-stock and dairy farming.

(4) There are a number of bad practices on the producer's part that not only lower the value of the product and thus lessen his profits, but are a source of constant trouble in the disposal of the hay. It is largely on account of such practices that buyers and commission men have been led to seriously consider the problem of how to prevent low-grade hay from going to market. The writer's investigations indicate that at present three-fourths of the low-grade market hay is the result of improper practices, such as allowing the meadow to become grassy and weedy, cutting too late, improper baling, etc., on the part of the producer, and is not caused by rain or unfavorable weather alone, as is generally supposed.

(5) In order to grow timothy hay successfully year after year, the farmer must also grow some legume crop in the rotation for either hay or pasture or as a green-manuring crop, which aids in keeping up the crop-producing power of the land.

Legume hay does not sell well in most markets, primarily because horse feeders have not yet learned the value of clover or alfalfa hay. A proper understanding of the value of these hays on the part of the feeders would be an enormous benefit to the whole hay industry.

The average horse feeder is too liable to think that the hay which is selling for the highest price on the market is the most valuable for all feeding purposes under all conditions. He should change some of his beliefs, especially in regard to some of the kinds of hay.

It is almost impossible to place a definite money value on any kind or grade of hay that will at the same time represent its true value to both producer and feeder. This is because the value may depend on several things, such as the purpose for which it is fed; the place where it is fed, for hay fed on the producer's farm has a different value to him than to the city feeder; the price of the more concentrated footstuffs; and the size of the total crop for the United States.

When considering the profit from hay growing the farmer must consider not only the cost of production, or growing, curing, baling, and marketing, but to a certain extent the value of the fertilizing elements which the crop removes from the soil.

The feeder should value any kind of hay according to the amount of digestible nutrients which it contains, its palatability, and its efficiency in keeping the horse in good condition and enabling it to accomplish the desired amount of work. The southern feeder especially should understand the value of hay, for there are many kinds and grades in southern markets.

SOUTHERN HAY TRADE.

A large quantity of low-grade hay is shipped south every year. This does not mean that the southern markets do not handle the better grades of hay, but that low-grade hay predominates. At present the southern hay dealer is anxious to solve the following questions:

(1) Where can I get more "choice" hay?

The trade is demanding more and more good hay each year, and although feeders are willing to pay a premium for this kind, the dealer is unable to get enough to supply their needs.

(2) What is the relative feeding value or standing of the different kinds of southern hay when compared with timothy hay?

Definite information is needed on this subject, because many farmers in what heretofore has not been a hay-producing section are beginning to grow hay, especially legume hay. They find that it pays to grow legumes for the beneficial effect that this class of plants has on the soil and because legumes when grown for hay are profitable, especially when sold on local markets. Timothy and red clover have not proved successful in the cotton-growing section of the South; therefore it is necessary to grow other kinds of hay to take the place of these. Cowpeas, soy beans, Bermuda grass, vetch, and alfalfa are being sown on increasing areas every year. The South is slowly but surely going into the hay business. It would seem that the time will come when competition in hay growing will force northern shippers to send only the best hay to the South, for the South has certain advantages over the North in producing hay, namely, cheaper land, a longer growing season, and nearness to market, all of which tend to favor the southern producer. At present most of the tame hay is grown in the northeastern part of the United States, and only a small amount in the South or West.

TAME HAY AREAS OF THE UNITED STATES.

According to the last census report, 75 per cent of the tame hay (not including alfalfa, clover, and grain cut green for hay) in the United States is produced in ten States. (See fig. 1.) For all practical purposes, the "other tame grasses" cut for hay referred to in the report may be regarded as timothy, especially in the northeastern part of the United States.

The percentage of the total crop that each State produces is as follows: New York, 14.3; Iowa, 10.7; Pennsylvania, 8.6; Missouri, 7; Illinois, 7; Ohio, 7; Michigan, 6; Wisconsin, 6; Indiana, 4.4; Minnesota, 3.2.

Three-fourths of the clover hay (see fig. 2) was grown in ten States, the percentages being: Indiana, 18.4; Ohio, 12.1; Missouri,

9.5; Illinois, 8.4; Pennsylvania, 6.5; Wisconsin, 5.8; Michigan, 5.1; Iowa, 4.5; Kansas, 4.1; Kentucky, 3.

In 1900, 75 per cent of the alfalfa was grown in six States, as follows: Colorado, 21.2; California, 16; Utah, 13.5; Kansas, 11.5; Idaho, 8.1; Nebraska, 5.2.

In 1865 there were about 21,000,000 tons of hay of all kinds produced; in 1905, 60,000,000 tons, or nearly three times as much. This large increase in amount produced is due almost entirely to greater acreage rather than to increased yield per acre.

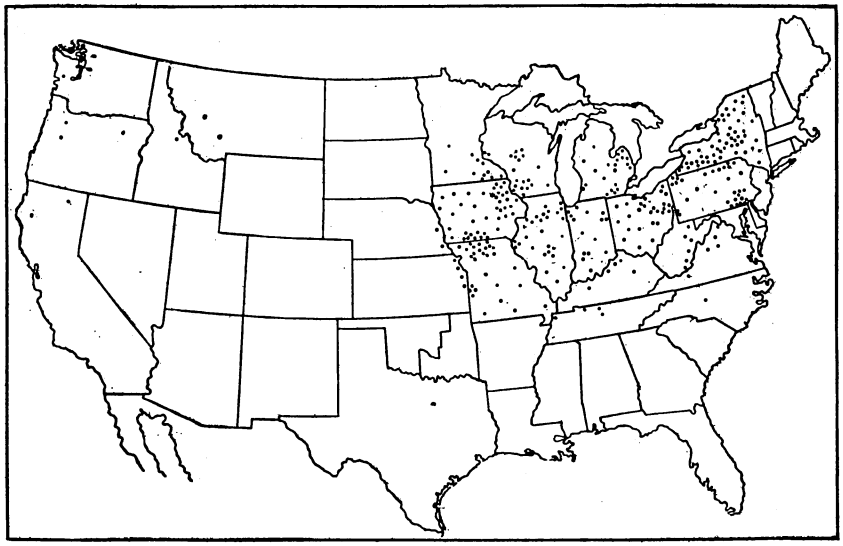

FIG. 1.—Map of the United States, showing the production of hay from cultivated and "other tame grasses," as reported by the census of 1900. Each dot represents 100,000 tons.

INCREASE IN YIELD PER ACRE OF HAY FROM 1865 TO 1905.

The average yield of hay in the United States from 1865 to 1870 was 1.28 tons per acre. This yield was exceeded but three times during the forty years from 1865 to 1905. The average yield for the third five-year period, ending with 1880, was 1.29 tons; that of the seventh five-year period was 1.35 tons; and that for the last five years was 1.47 tons per acre. The average yield for the last period shows an increase of 0.19 ton over that for the first period, and an increase of 0.21 ton over the average yield for forty years, which is 1.26 tons per acre. (See fig. 3.)

The average yield per acre in the ten leading timothy-hay-producing States for forty years varies but little from that for the entire United States. There is a slight difference during the first twenty-five years, when the yield was above that for the United

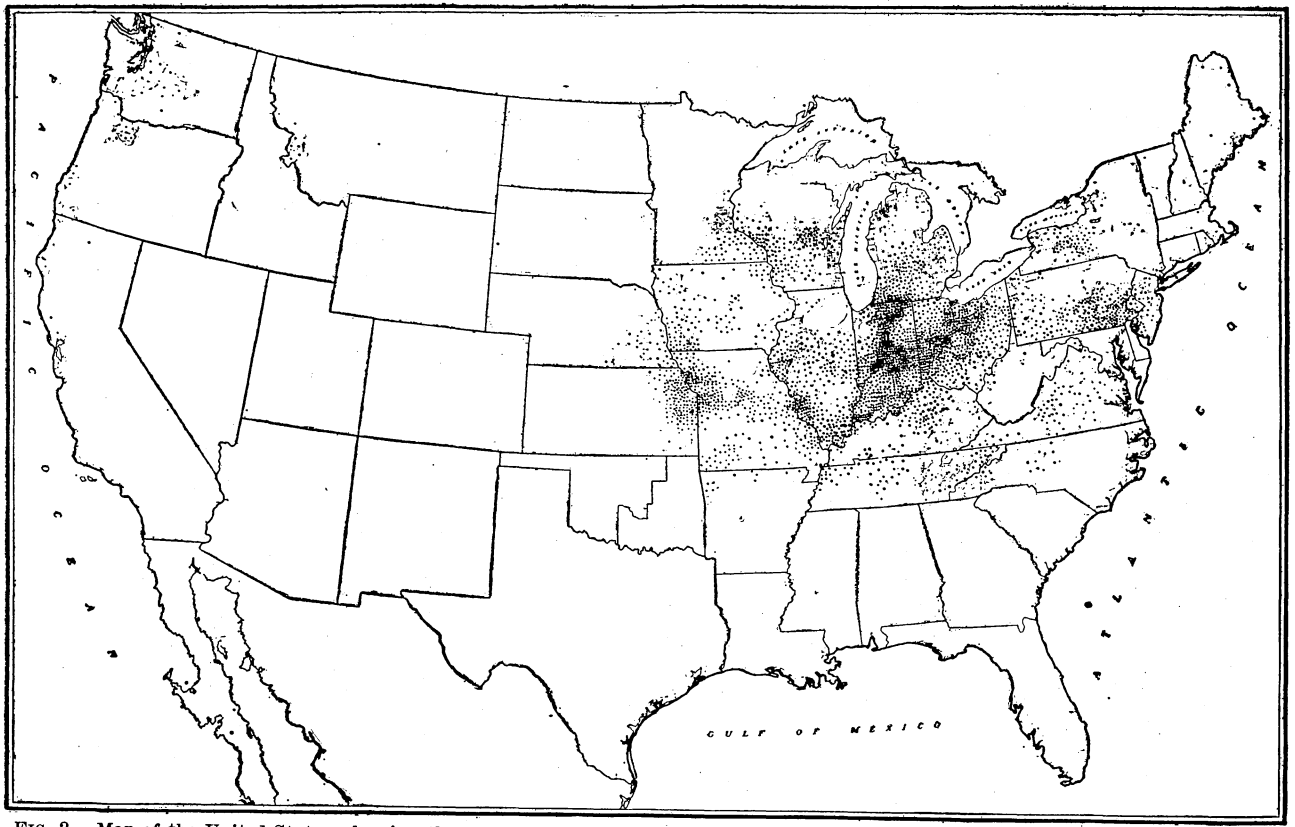

FIG. 2.—Map of the United States, showing the clover-hay area, as reported by the census of 1900. Each dot represents 1,000 acres.

States. The yield during the last fifteen years was nearly the same for both.

The average yield for the ten timothy States for the first five-year period was 1.42 tons per acre. This yield was only equaled once

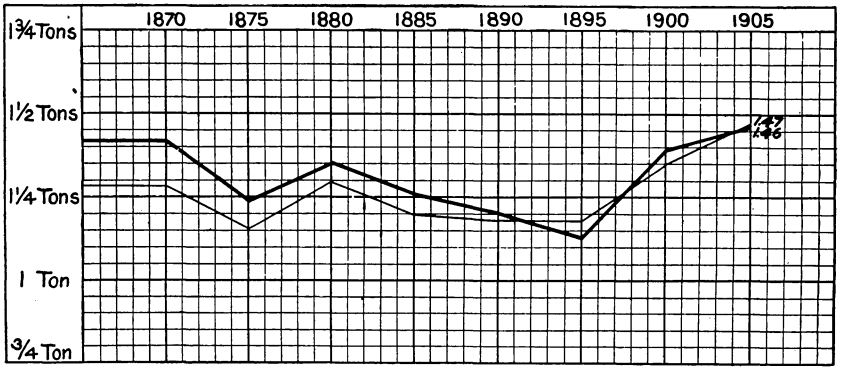

FIG. 3.—Diagram showing the average yield per acre of hay, for periods of five years, 1865 to 1905, for the United States and for the ten leading timothy-hay-producing States. The light line represents the United States as a whole; the heavy line, the ten leading States.

during the entire forty years. This was during the last period, when the yield amounted to 1.46 tons per acre. The yield for the last period shows a gain of 0.04 ton over the yield for the first period, a gain of 0.06 ton over the average for forty years for these States, and a gain of 0.20 ton over the average for forty years for the United States.

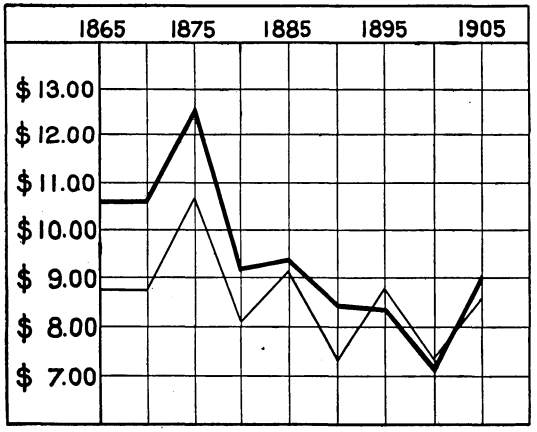

FIG. 4.—Diagram showing the average farm value per ton of hay on December 1, for periods of five years, 1865 to 1905, for the United States and for the ten leading timothy-hay-producing States. The light line represents the United States as a whole; the heavy line, the ten leading States.

After forty years of hay growing the yield per acre for the United States is just a little more than it was in 1870. There are perhaps two reasons for the rising yield during the last ten years of this period—first, within the last ten years better farming has been practiced than during the ten or fifteen years previous; second, the alfalfa area has been greatly increased during the last few years.

Alfalfa yields considerably more per acre than the grasses or clovers, and this tends to raise the average for the United States.

PRICE OF HAY FOR FORTY YEARS.

The price received for hay is the governing factor in determining the profits in growing hay. As shown by figure 4, the average farm value of hay per ton for the first five-year period of the forty years from 1865 to 1905 was $10.61 for the United States and $8.75 for the ten leading timothy-hay-producing States. The highest five-year period for both groups was from 1870 to 1875. These prices have not been equaled since that time, although the farm value since 1900 is higher than it has been since 1885. The average farm value per ton for the forty years was $9.30 for the United States, as compared with $8.58 for the ten timothy States.

INCREASING VALUE OF HAY LANDS.

There is no doubt that during the forty years from 1865 to 1905 farmers have made money when growing the average yield of nearly a ton and a half and selling it for approximately $9 a ton, but within the last few years another factor has entered which has greatly changed the profits on hay growing for the market. This is the increasing value of hay and grain land. The following table[a] shows the increase in value of such land in some of the States in the northeastern section of the United States.

TABLE 1.—*Average real estate value per acre of medium farms with at least two-fifths of income derived from hay and grain, 1900 and 1905.*

State.	Value in 1900.	Value in 1905.	Increase during five years.	
				Per cent.
New York	$40.29	$44.38	$4.09	10.2
Pennsylvania	40.24	43.95	3.71	9.2
Ohio	48.34	58.34	10.00	20.7
Indiana	43.84	57.67	13.83	31.5
Illinois	57.24	78.89	21.65	37.8
Michigan	30.01	36.39	6.38	21.3
Wisconsin	36.44	47.19	10.75	29.5
Minnesota	28.11	35.04	6.93	24.7
Iowa	51.95	66.10	14.15	27.2
Missouri	25.54	36.09	10.55	41.3
North Dakota	11.03	18.82	7.79	70.6
South Dakota	14.54	24.00	9.46	65.1
Nebraska	23.32	36.58	13.26	56.9
Kansas	17.47	27.53	10.06	57.6

The increase in value per acre ranges from 20 to 70 per cent for the States west of Pennsylvania. The increased yield per acre and price per ton during this time is insignificant when compared with

[a] From Bureau of Statistics, Bulletin No. 43, "Changes in Farm Values."

the large increase in value of hay land. The point to be remembered is this, that as land increases in value the yield per acre must be increased in like proportion in order to realize the same profit on the investment, provided the price per ton remains the same or nearly so.

FERTILIZING ELEMENTS IN HAY.

It is time for the producer to figure very closely on the cost of production, especially for the different kinds of hay. Throughout the East and South commercial fertilizers are being used in large quantities, and this practice is gradually extending westward to the great Mississippi Valley States. Every crop takes certain elements of plant food from the soil. It has been found that ordinary soil becomes exhausted first of its supply of available nitrogen, phosphorus, and potassium. It is these three elements which are bought and applied in the form of commercial fertilizers in order to get paying crops. The producer, whether he uses commercial fertilizers or not, should know that when hay is removed from the farm there is a loss of fertilizing elements which are of value to him but not to the city feeder.

There is quite a difference in the amount of plant food contained in different kinds of hay plants. For example, one ton of timothy hay contains, on an average, 20 pounds of nitrogen, 10 pounds of phosphorus, and 28 pounds of potassium.

If bought in the form of a commercial fertilizer, nitrogen is worth 20 cents a pound and the other two elements are valued at 5 cents each per pound. On this basis the fertilizing value of a ton of timothy hay will amount to $5.90, or $6 in round numbers.

One ton of clover hay contains, on an average, 40 pounds of nitrogen, 8 pounds of phosphorus, and 40 pounds of potassium, which makes its fertilizing value amount to $10.40.

According to these figures it would seem that there is less loss of plant food in growing timothy than when clover is grown. However, such is not the case, for clover and all other leguminous plants store up nitrogen in the soil. This class of plants is supplied with a certain kind of bacteria, which live in the tubercles on their roots. These bacteria have the power of taking free nitrogen from the air and making it available as food for the growing plant. Much of the nitrogen thus secured is left in the soil by the decay of the tubercles, roots, stems, and fallen leaves of the legumes, to the great benefit of succeeding crops.

When a ton of clover is removed from the soil, from one-fourth to three-fourths as much nitrogen is left in the roots and crowns and in the fallen leaves and stems left on the ground as is removed in the hay. As a greater part of this nitrogen came from the air, it is per-

fectly fair and proper when considering the loss of plant food in growing a crop of clover to disregard or deduct it from the total fertilizing value of the hay.

When comparing the loss of fertilizing elements of clover and timothy, there is a difference of about $3 a ton in favor of clover hay. Just how much of this amount should be charged to the hay when considering the profit from selling hay can not be stated definitely, for the kind of soil, system of rotation used, and type of farming play important parts in keeping up the crop-producing power of the soil.

Timothy is often said to be "hard" on the soil. This is because neither timothy nor any other grass can add any plant food to the soil in the manner that the legumes do, but must get all of its food from the soil; and it is therefore much more exhaustive of the available plant food in the soil than clover.

NEED OF SUITABLE ROTATIONS FOR HAY LANDS.

When crops are sold from the farm year after year and no attempt is made toward a systematic rotation, and especially where legumes are not grown, the land in the course of time will become low in available plant food and the yield will be greatly lessened. In fact, on many farms the soil has been so depleted of its fertility that farming is not a paying proposition. It has been found that when land begins to lose its crop-producing power the loss of fertility may be retarded by a proper rotation of crops in which legumes, such as clover, alfalfa, cowpeas, and soy beans, are grown.

Many farmers who in the past have grown nothing but timothy hay for the market are now commencing to grow clover in order to help build up their land. This is why under certain conditions farmers grow kinds of hay which at present are not in greatest demand in the market. This year there is more straight clover and clover-mixed hay sent to the market than usual, and dealers sometimes have difficulty in getting enough timothy hay to supply their trade. It would seem from our observations that there is less timothy hay and more clover being grown each year, and the reasons just given show why the timothy area is decreasing.

Even though the greatest demand is for timothy, the average feeder will not suffer in any way if he is not able to get it, because there are other kinds of hay that will not only take the place of timothy but prove a better and more economical feed. Under ordinary conditions the shipper and the receiver make just as much money by handling one kind of hay as another, so that it is really better for all concerned if there is a smaller quantity of timothy hay produced than formerly. It is necessary, however, for the feeder to under-

stand the feeding value of the different kinds of hay before there can be any great change in the demand for these other kinds, for it is the feeder who makes the price of hay in the market. In order to feed intelligently it is necessary to consider the functions of the nutritive substances.

NUTRITIVE SUBSTANCES IN HAY.

The nutritive substances in hay or feed may be divided into two classes—flesh formers and fuel or energy producing substances. When the proper amount of these two classes of substances is fed the ration is said to be balanced. If an unbalanced ration is fed, as one containing more fuel or energy producing substances than are needed and less flesh-forming material, the ration is partially wasted, and such unwise feeding will not bring as good results as the feeding of the same amount of a balanced ration. Each class of substances has different offices to perform in the body. If not enough flesh-forming substance is fed, the body suffers, because it is absolutely necessary to keep the body in good condition. Thousands of horses are fed all they can eat, yet are poorly nourished because the food contains little except fuel substances.

The flesh-forming substances are used to replace the waste that goes on in all living tissue. Energy-producing substances are used to furnish the energy required for the nervous and muscular activities of the body, and when fed in excess they may to a certain extent be stored up in the form of fat for use later, when needed for either energy or heat.

One of the most important substances in any foodstuff is protein. All nutritive substances which contain nitrogen are classed under the general term of protein. Protein is composed of nitrogen, carbon, hydrogen, oxygen, sulphur, and phosphorus. Protein is the substance which builds up the body. The muscles, tendons, ligaments, connective tissues, skin, hair, hoofs, part of the bone, and in fact every part of the body but fat are made up of protein, together with mineral matter and water.

The next important class of substances is the carbohydrates, which contain carbon, hydrogen, and oxygen, but no nitrogen, sulphur, or phosphorus; they include starch, sugars, etc. These are used for practically the same purpose for which coal or wood is used in the steam engine, namely, to furnish energy and heat.

The third important constituent of hay is its oils. Small quantities of oil are present in all kinds of hay. These oils serve the same purpose as the carbohydrates. A pound of these, however, will furnish two and one-fourth times as much energy or heat as the same

quantity of carbohydrates. It can readily be seen, when the chemical analysis of hay is considered, why the price of the different grades or kinds of hay should depend, first, upon the amount of digestible nutrients contained, and, second, upon the purpose for which the hay is fed. If the concentrated feed—i. e., the grain in the ration—lacks protein, then the hay that is high in this substance is more valuable than one which contains little but carbohydrates, and vice versa. There is quite a range in the amount of the different classes of nutrients in the various kinds of hay. (See fig. 5.)

On an average, in 100 pounds of alfalfa hay the digestible protein amounts to 10.58 pounds; in cowpea hay, 10.79 pounds; in alsike clover hay, 8.15 pounds; in red clover hay, 7.38 pounds; in redtop hay, 4.80 pounds; and in timothy hay, 2.89 pounds.

In 100 pounds of redtop hay the digestible carbohydrates amount to 47 pounds; in timothy hay, 43.72 pounds; in alsike clover hay, 41.70 pounds; in alfalfa hay, 37.33 pounds; in cowpea hay, 38.40 pounds; in red clover hay, 36.15 pounds.

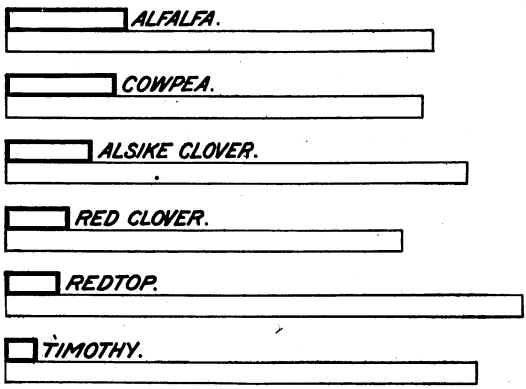

FIG. 5.—Diagram showing the relative amounts of digestible protein and carbohydrates in different kinds of hay. The sections inclosed in light lines represent the carbohydrates; those inclosed in heavy lines, the protein.

When fed for protein, timothy hay ranks last, but when fed for carbohydrates it stands next to redtop, which heads the list. If the total nutrients are considered there are a number of different kinds of hay which are equal, if not superior, to timothy hay for feeding purposes. If cut at the right time and properly cured, Johnson grass and Bermuda grass hay are about equal to timothy in amount of nutriment contained.

PALATABILITY OF HAY.

There is another factor which is very important in determining the feeding value of hay; this is palatability. A hay may be high in nutrients, but if it lacks palatability it is not as valuable a feed as a hay that is poorer in nutrients but is very palatable. Timothy is a very palatable hay, and this is one of the chief reasons why it is

standard in most markets. In addition to this, a horse can be fed a large quantity of it and will suffer no ill effects if given a hard drive immediately after having eaten the hay.

Palatability may depend largely on the time the hay is cut and on the method of curing. Redtop may be cited as an example. It is quite generally true that in most markets feeders discriminate severely against redtop whenever it is found mixed in with any other kind of hay. They claim that redtop has no feeding value and that horses will not eat it. The point that the feeder overlooks is that when redtop is cut too late it has a bitter taste, is not palatable, and horses do not relish it, but if cut early it has a sweet taste, is very palatable, and is more nutritious than timothy hay. When buying timothy that contains redtop, feeders should examine it carefully in order to see if the redtop was cut early and properly cured. If it is properly cut and cured it does not lower the quality or feeding value of the timothy, but if found to have been cut late then the bid should be lowered accordingly. It is very seldom that redtop is cut at the proper time, and it is safe to say that perhaps not over one-half of the crop is cut early enough.

Again, there are kinds of hay that when first fed appear to lack palatability, but after the horse has acquired a taste for the hay he does very well on it. On the other hand, some kinds are eaten greedily when fed for the first time. Alfalfa is a hay that is usually very palatable when first fed. In fact, for horses palatability may be an objection in some cases. Many horse feeders have tried alfalfa and are of the opinion that it is of no value for horses.

Upon careful inquiry it has been found that in a large percentage of the cases where serious results were experienced from feeding alfalfa it was on account of ignorance as to the nutritive value of the hay. Unwise use, such as feeding in too large quantities, has led many to become prejudiced against it. If alfalfa hay is properly fed it will be found one of the most valuable feeds, especially for heavy draft horses.

DIGESTIBILITY OF HAY.

The digestibility of the nutrients in hay is another factor that is important in determining its value. If only a small part of the nutrients is digestible, or if a part has been lost by faulty methods of haymaking, then the feeding value is lowered correspondingly. The digestibility may be lowered and the total amount of nutrients lessened by improper curing and handling of the hay.

Plants like clover and alfalfa which have a large amount of nutritious leaves often lose a considerable portion of them on account of poor methods of curing. Alfalfa hay cured under ordinary condi-

tions will lose from 15 to 20 per cent of its leaves. The loss may amount to from 50 to 60 per cent. Alfalfa hay which has lost the greater part of its leaves and consists mostly of stems is often found in the market; consequently, it is only about half as valuable for feeding purposes as when the greater percentage of the leaves is saved.

The Colorado Agricultural Experiment Station found that when alfalfa hay was exposed in the field for fifteen days, during which time it was subjected to three rains, amounting to 1.76 inches, the damaged hay contained but 11 per cent of protein, as compared with 18.7 per cent originally.

In an experiment [a] to determine the loss due to rain, part of a field of grass hay was left in the cock and part in the swath during a rainy spell of eighteen days' duration. At the end of this time the hay in the swath lost 38.8 per cent of its digestible protein, while that in the cock lost only 19.8 per cent. The total nutrients lost in the swath were twice as great as those lost in the cock. This experiment shows that the value of hay cured during unfavorable weather depends a great deal upon the manner or system used in curing hay. Such things as these are of the utmost importance to the feeder. So far as it is possible to determine from an examination of the hay, the price paid should depend on its value for feeding purposes. If this were so it would stimulate the producer to make every effort to cure his hay so as to get the best quality. If he received more for the better grades it would tend to discourage the production of low-grade hay.

AROMA OF HAY.

Although there is no way of determining aroma, this quality of hay adds greatly to its feeding value, or rather its palatability. The writer knows one hay grower who has made quite a reputation on account of the aroma of his hay, and for this reason it outsells that of his neighbors every year. There is a good reason why hay should not lie too long in the swath. When hay lies too long in the sunlight the bleaching which takes place indicates that chemical changes are going on, and these are not of advantage to the hay. Hay that is cured with the least possible exposure to the sun and to dew and rain will have the best aroma.

GRASSY AND WEEDY HAY.

One of the greatest causes of low-grade hay is the presence therein of fine grasses and weeds of various kinds. The rule for determining choice hay is that it must not contain over 5 per cent of other tame and cultivated grasses properly cured, should have a bright natural

[a] Landwirtschaftliches Wochenblatt für Schleswig-Holstein, 1891, pp. 569–571.

color, and should also be sound and well baled. It may happen that good timothy hay will contain quite a large percentage of other grasses and still not have its feeding value lowered in the least, although according to the rules for grading it will not grade as choice.

If the other grasses ripen at exactly the same time as timothy and are properly cured, then the feeding value is not lowered. However, it is very seldom that the grasses which so frequently occur in timothy are cut at the proper time. They are usually past maturity when the timothy is ready to cut, and hence are of but little value for feed. They make the hay appear "off color" and greatly lessen its palatability. In such cases the inspector is perfectly justified in grading the hay down, although by so doing he may lower the grade and price just enough to take away the profits, or even cause a loss to the man who handles the hay. The reason so much grassy and weedy hay is sent to market every year is because most meadows are kept for hay too long. There are many meadows in the eastern part of the great hay section that are cut from six to twelve years. During this time the yield has become very low and weeds and fine grasses have entered to lower the quality. With such a mixture it is impossible to produce choice marketable hay, no matter how early it is cut or how efficient are the methods of curing.

How long a meadow should remain in hay is a question that can easily be determined by studying conditions, such as decreasing yield, appearance of volunteer grasses, weeds, etc. The length of time a field should remain down in hay will depend on the fertility of the soil, the treatment it has in the way of reseeding, and the application of barnyard manure or commercial fertilizers. A newly seeded timothy meadow on good soil should yield on an average from 2½ to 3 tons or more of hay the first year. After about the third year the yield begins to fall off until it will remain constant between three-fourths and 1½ tons per acre. This shows why it is so important to know when a meadow should be plowed up and a new meadow started, so that larger or paying yields may be obtained.

This Department has made a special study of crop rotations for hay and grain farms and is willing at all times to place information in the hands of those who wish to better their conditions in regard to hay growing. In planning a cropping system it is seldom advisable to keep the meadow in hay longer than three or four years at the outside. As soon as the yield begins to lessen, the meadow should be plowed up and put into some other crop and a new meadow seeded on land which is free from weeds and other grasses.

Late cutting and the presence of weeds and weedy grasses are the greatest causes of low-grade hay. It is very seldom that timothy hay grades low simply on account of being damaged by rain. Choice

hay must have a bright, natural color, according to the rules of the National Hay Association. Chemical analysis shows that when timothy is cut at full bloom it contains the greatest amount of total nutrients. If cut at the beginning of the blooming period it contains the greatest amount of digestible protein. No matter how successful are the efforts to get farmers to use better methods, the time is not likely to come when the market will become stagnant and dull on account of an overabundance of choice hay.

LOW-GRADE HAY ON THE MARKET.

How to dispose of low-grade hay is a vital problem with everyone who handles this class of hay, and every dealer has more or less of it, usually more low-grade hay than any other kind. The shippers, receivers, and dealers can help very much in solving this perplexing problem. The country buyer and shipper, especially, can help very materially and should use every fair means in his power to lessen the trouble caused by low-grade hay. The first step in the right direction is for the producer to learn the different grades of hay. It is just as important for him to know the grades of hay as it is for the city buyer.

Too many farmers claim always to have good hay, no matter how late it was cut, or how much foreign material, weeds, etc., it contains, or how inefficient was the method of curing. Hay in the city markets sells on grade, and it was found out long ago that this is the only way to sell hay successfully. This being true, why not buy hay in the country according to its grade? There is no good reason why if this practice will work in the city it will not work in the country. Country buyers in many localities buy hay the year round, and the subject of grade is either not mentioned or if it is most of the hay is classed as No. 1 in order to make a sale.

The writer has visited a number of farms where the hay consisted of perhaps one-half timothy and the remainder made up of red clover, alsike clover, redtop, Kentucky bluegrass, wire-grasses, and weeds of various kinds (see fig. 6). When the producer is informed that the market does not want that kind of hay, he replies that he has been growing just that kind of hay for a number of years and that buyers have always taken it, and that it sold about as well as any in the neighborhood. This shows very clearly that the average producer does not know the true grades of hay, having sold inferior grades of hay for the better grades for so long that he thinks there is no reason why he should make extra efforts to grow hay that is free from other grasses and weeds and cut it at a certain time and cure it in a certain way.

If hay sells on grade in the country the man who has the poorest hay will receive less than he does now. At present the man who has choice hay receives less than it is worth on the market, and part of the profit which the shipper makes on the good hay must go to make up for the loss on the poor hay. With the present system of buying hay there is not enough difference in the price paid for the better grades in the country; therefore, if the man who has No. 2 hay receives within 50 or 75 cents as much as does his neighbor who has choice hay, he is satisfied and thinks that it is not necessary to take the precautions that his neighbor did in order to get a slight advance in price.

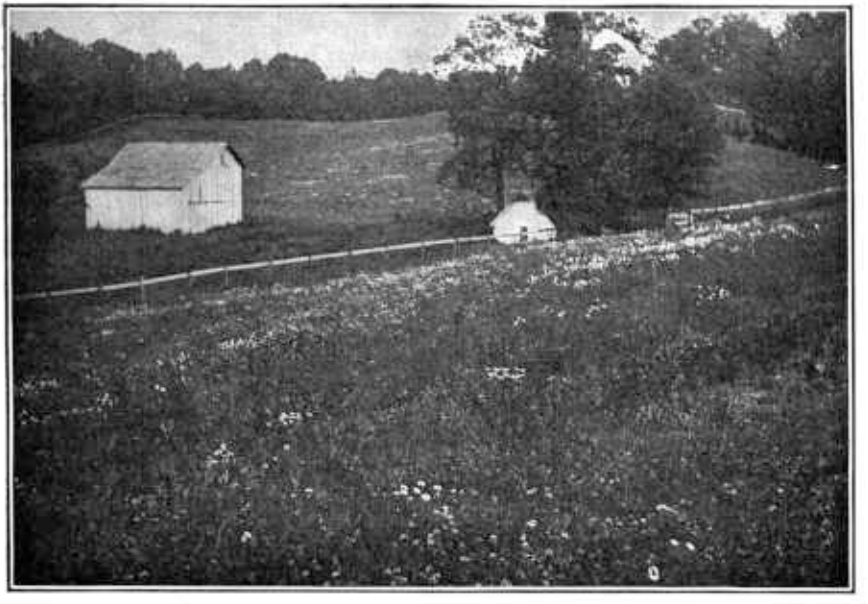

FIG. 6.—View of a meadow, showing a growth of various grasses and weeds. It is impossible to make "choice" hay from a meadow like this.

A firm in Illinois buys hay somewhat according to its grade. It buys a great deal of new hay as soon as it is in good condition to bale, and has a sort of sliding scale, paying the highest price for the hay that is cut early and properly cured. The price is lowered for that which was cut as it approached maturity, depending on the number of days the grass stood after the proper time for cutting. The farmers like this way of selling their hay, and make special efforts to cut it in time to secure the extra profit which the higher price paid at the beginning allows them. This way of selling is successful because farmers have learned the grades of hay and know that they must have choice hay in order to secure top prices.

The causes for hay being graded low, such as its being cut too late, the presence of weeds and fine grasses, and improper methods of curing and baling, can easily be remedied. When intelligent farmers produce low-grade hay it is not on account of the reasons just stated, but because of rains during the haying season. The ordinary methods of curing hay in wet weather usually result in a product that has but little feeding or market value. There are methods of curing hay in wet weather by which a fair grade can be obtained, and its increased value will more than pay for the extra labor involved. The subject of curing is a large one and details of methods can not be given in this paper.

VALUE OF LOW-GRADE HAY.

As long as the present system of buying is in vogue, just so long will the problem of how to dispose of low-grade hay remain unsolved. Therefore, the first thing to do to keep low-grade hay from going to market is to make a readjustment of the price paid for it in the country, so that the different grades will correspond more nearly with those for which the hay is sold in the city. If this system is adopted it will aid materially in decreasing the production of low-grade hay. If the poor hay does not go to market then the question arises, What shall be done with this kind of hay? Low-grade hay is much more valuable to the producer than to anyone else if he will feed it on his farm. This is true, first, because he will save the cost of baling and hauling, and, second, because a ton of timothy hay contains fertilizing elements to the value of about $6. If fed and the manure is well taken care of and returned to the soil at least one-half of the fertilizing elements will become available for the succeeding crops.

Low-grade hay makes a fair roughage for idle work stock and other stock that are being "roughed" through the winter. After getting considerable out of the hay by feeding, there is still about $3 worth of plant food to return to the soil. As a general thing, selling crops from the farm does not represent the highest type of farming, and it is only under certain conditions that it is profitable without lowering or seriously affecting the productivity of the land.

GRADES OF HAY ADOPTED BY THE NATIONAL HAY ASSOCIATION.

In order that the farmer may know definitely what are the different grades of hay, the rules of the National Hay Association, which have been generally adopted in the United States, are quoted herewith.

Choice timothy hay.—Shall be timothy not mixed with over one-twentieth other grasses, properly cured, bright natural color, sound, and well baled.

No. 1 timothy hay.—Shall be timothy with not more than one-eighth mixed with clover or other tame grasses, properly cured, good color, sound, and well baled.

No. 2 timothy hay.—Shall be timothy not good enough for No. 1, not over one-fourth mixed with clover or other tame grasses, fair color, sound, and well baled.

No. 3 timothy hay.—Shall include all hay not good enough for other grades, sound, and well baled.

No-grade hay.—Shall include all hay badly cured, stained, thrashed, or in any way unsound.

Light clover mixed hay.—Shall be timothy mixed with clover, the clover mixture not over one-fourth, properly cured, sound, good color, and well baled.

No. 1 clover mixed hay.—Shall be timothy and clover mixed, with at least one-half timothy, good color, sound, and well baled.

No. 2 clover mixed hay.—Shall be timothy and clover mixed, with at least one-third timothy, reasonably sound and well baled.

No. 1 clover hay.—Shall be medium clover not over one-twentieth other grasses, properly cured, sound, and well baled.

No. 2 clover hay.—Shall be clover, sound, well baled, not good enough for No. 1.

Choice prairie hay.—Shall be upland hay, of bright natural color, well cured, sweet, sound, and may contain 3 per cent of weeds.

No. 1 prairie hay.—Shall be upland, and may contain one-quarter midland, both of good color, well cured, sweet, sound, and may contain 8 per cent of weeds.

No. 2 prairie hay.—Shall be upland of fair color, and may contain one-half midland, both of good color, well cured, sweet, sound, and may contain 12½ per cent of weeds.

No. 3 prairie hay.—Shall include hay not good enough for other grades and not caked.

No. 1 midland hay.—Shall be hay of good color, well cured, sweet, sound, and may contain 3 per cent of weeds.

No. 2 midland hay.—Shall be fair color or slough hay of good color and may contain 12½ per cent of weeds.

Packing hay.—Shall include all wild hay not good enough for other grades and not caked.

No-grade prairie hay.—Shall include all hay not good enough for other grades.

Choice alfalfa.—Shall be reasonably fine, leafy alfalfa of bright green color, properly cured, sound, sweet, and well baled.

No. 1 alfalfa.—Shall be coarse alfalfa or natural color or reasonably fine, leafy alfalfa of good color, and may contain 5 per cent of foreign grasses, must be well baled, sound, and sweet.

No. 2 alfalfa.—Shall include alfalfa somewhat bleached, but of fair color, reasonably leafy, not more than one-eighth foreign grasses, sound, and well baled.

No. 3 alfalfa.—Shall include bleached alfalfa or alfalfa mixed with not to exceed one-fourth foreign grasses, but when mixed must be of fair color, sound, and well baled.

No-grade alfalfa.—Shall include all alfalfa not good enough for other grades, caked, musty, greasy, or thrashed.

In years when the total crop of the United States is an average one there is not much profit per ton to the producer on low-grade hay,

and it is only when there is a scarcity that he can dispose of it advantageously. He should get every cent his good hay is worth and not have to help even up the price which is paid for the poor hay that others in his vicinity grow. The only way he can realize the most from his crop is to know its kind or grade, so that he can sell it intelligently.

LOSS CAUSED BY STACKING HAY.

The feeding value of hay is often lowered when it is stacked out in the open. (See fig. 7.) Considerable hay is often entirely spoiled

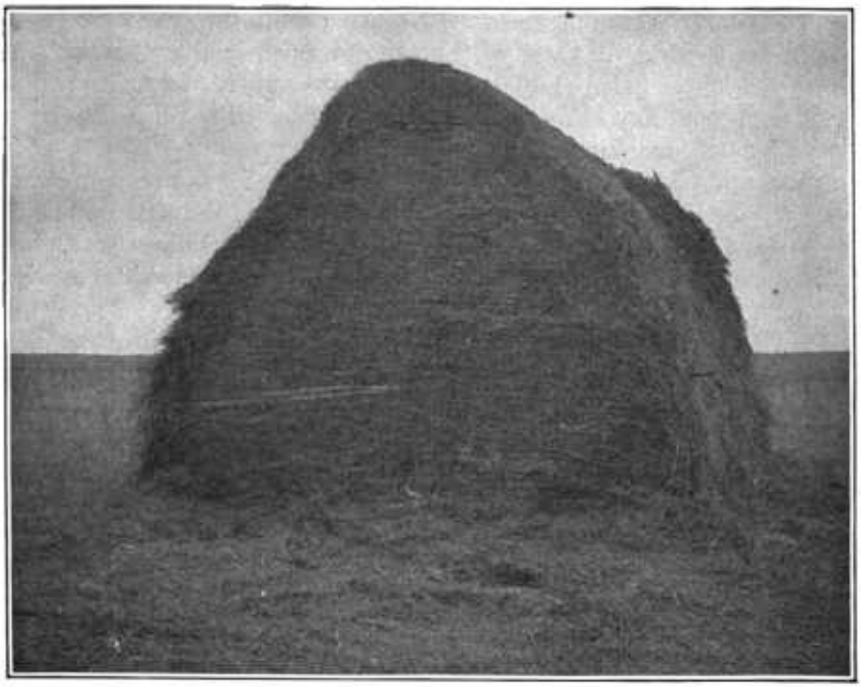

FIG. 7.—Stack of hay, showing deterioration caused by exposure to the weather. The darker portion shows the quantity spoiled in about six months.

so that it is unfit for feeding. The amount of spoiled and damaged hay depends upon the time the stack stands and upon the method of stacking. In Virginia a 6 to 8 ton stack of timothy hay, after it has gone through the sweat, or in three or four weeks, will have from 300 to 600 pounds of damaged hay. Most of this will be on the top and only a small portion on the sides and the bottom.

The market value of hay is frequently lowered because this stained hay is worked into the bales. It may happen that the spoiled hay will be no more than a couple of handfuls, which amount is really

insignificant, but the inspector can not tell how much the bale contains, so he is forced to grade it one or two grades lower. This causes quite a loss to those who sell hay.

In Iowa and surrounding States considerable hay is stacked in the field, and the loss due to stacking is not thought to be enough to warrant the building of a barn for hay only.

In 1907 experiments were carried on by Mr. C. Lipscomb, of Liberal, Mo., to determine what the loss would be when timothy remained in the stack for several months. The hay was hauled with a wagon and pitched on the stack by hand, one man doing the building or stacking.

Two stacks were put up in 1907 under conditions that would compare favorably with those of the average farm in this section. The first stack was baled the latter part of December. In order to find out the loss of hay at market prices it was decided to put as nearly as possible only one kind of hay into a bale.

When hay is baled by the ton it is customary for the crew to throw out the spoiled hay from the top of the stack. If the sides are badly spoiled, all that can be removed easily with a fork is also thrown out. The balance is baled with the good hay, which results in there usually being several grades in a bale.

In this experiment the sides were raked off very carefully with a garden rake and all bad spots were cut out with a hay knife. When the baling was finished there were two grades instead of several, as is often the case. These grades were a fair No. 1, and a "No-grade" hay, there being 13,990 pounds of the former and 2,870 pounds of the latter, which made the loss of unsalable hay amount to nearly 20 per cent.

The second stack was baled the following March and the loss amounted to a little over 40 per cent.

The reason why the loss seemed so large was because nothing but the good hay was baled. Of course in raking out the spoiled hay a little good hay was lost, but the amount was insignificant. Had the badly stained hay been baled with the good, as is often done, the loss in pounds would have been less, but hay baled in this manner would have brought less total profit than was received by baling only the good hay. The reason for this, as stated previously, is because the presence of any stained or spoiled hay on the outside of the bale, even though it be a small amount, causes the buyer to become suspicious and think that the hay is "sandwiched." Had the stacks been put up by the use of sweep rakes and stacking machines, the loss would probably have been less because the stack would have been more compact and not so liable to let in rain or settle with soft spots.

On an 80-acre field yielding a ton and a half of hay per acre, a 20 per cent loss would amount to 24 tons, or $192 when hay is worth $8 per ton, which was its value in December, when the first stack was baled. The loss on an 80-acre field, if baled at the time the second stack was baled, would have amounted to $384. According to these figures a hay barn would pay for itself in a few years.

VALUE OF CLOVER HAY.

In the past horse feeders have not understood the value of clover hay. Clover should constitute one of the main coarse roughages for horses. It has been found to be more nutritious than timothy and nearly equals alfalfa in this respect. Feeders object to it, however, because of its tendency to produce heaves and other respiratory troubles when fed in a dusty or otherwise unclean condition. These objections do not apply to clover which is cut at the right time, properly cured, and free from dust and mold. Moldy clover will often cause acute indigestion and even death. Those who do not care to feed straight clover will find that the grade of light clover mixed will give better results than timothy, and there is no good reason why it should not be used extensively throughout the eastern half of the United States.

CONCLUSIONS.

(1) A large percentage of market hay, especially timothy, is below a No. 1 grade. The chief reasons for this are: First, meadows are cut for a number of years after the yield has materially decreased and other tame grasses, wire-grasses, and weeds have become so numerous as to prohibit the hay grading either choice or No. 1. Second, in many localities timothy is cut too late. When cut at the end of the blooming period or when the seed is beginning to ripen, it is impossible to secure the natural green color that timothy must have in order to grade choice according to the rules of grading as adopted by the National Hay Association, which are used by most cities having official inspection. As a result of these practices producers are losing thousands of dollars every year.

(2) There are two main reasons why timothy has for a number of years been regarded as the standard market hay in the eastern half of the United States. First, formerly very little tame grass of any other kind was grown for hay in the great tame-hay section; consequently market hay consisted of wild or prairie hay and timothy hay. Second, timothy is a valuable hay for two reasons: It is a very palatable hay, and horses therefore eat it readily; it has no bad

effects, as there is no danger of the horse overeating, and it is non-laxative. For these reasons feeders have become used to timothy for feeding to all classes of horses.

(3) The writer's investigations lead him to believe that the clover-hay area is increasing each year and that more straight clover and clover and timothy mixed is sent to the market than formerly. The reasons for this increase in the clover area are, first, that farmers are now beginning to realize more than ever before the value of clover in keeping up the crop-producing power of the soil; and, second, that when clover hay is sold from the farm there is less loss of plant food than when timothy hay is sold. Because of the increased amount of clover-mixed hay sent to the market a new grade called light clover mixed has recently been added to the official grades.

(4) At present clover-mixed hay, especially light clover mixed, brings about the same price as No. 2 timothy. The reason this kind of hay is not in greater demand and does not bring a better price is that feeders do not realize that it contains more nutrients, especially protein, than timothy, and that it will give better returns when fed to horses subject to hard labor, such as heavy hauling and transferring.

(5) Before the value of any kind of hay can be determined, the feeder must know the purpose for which it is to be fed and its adaptability for such a purpose. For example, owners of racing and fancy driving horses feed the choicest of timothy hay, chiefly because it is very palatable, agrees with the horse, and furnishes the required amount of bulk needed in the ration. The purpose in feeding hay to horses doing hard labor is to furnish not only bulk but part of the nutrients, especially protein, required in the ration. For this class of horses good timothy and clover mixed hay will prove more satisfactory than any grade of timothy, being cheaper and containing more nutrients than timothy.

(6) The most important thing in determining the value of hay is palatability, for if it is not relished not enough will be eaten to furnish much nourishment to the animal. When hay is exposed in the field too long in the hot sun or is subject to rain, its palatability will be lessened, which in turn lowers its market and feeding value. Low-grade hay is not as palatable nor does it contain as much nourishment as the better grades.

(7) In general there is little if any profit in growing and selling low-grade hay, especially that made from the grasses, for the loss of fertilizing value or crop-producing power of the land amounts to more than the net profit after the cost of curing, baling, etc., is deducted.

(8) The price of hay land is steadily rising in the tame-hay section, and in order to make a fair profit on the value of the land it will be necessary for the grower to practice the best methods of culture, curing, baling, and selling. Before there can be any material change in the quality of hay sent to the market it will be necessary for farmers to learn the grades of hay, for it is impossible to grow choice hay if the producer does not know what constitutes this grade.

(9) A proper understanding of the feeding value of market hay and market requirements is greatly to be desired on the part of everyone engaged in the growing, handling, and feeding of hay.

FARMERS' BULLETINS.

Bulletins in this list will be sent free, so long as the supply lasts, to any resident of the United States, on application to his **Senator, Representative, or Delegate in Congress,** or to the Secretary of Agriculture, Washington, D. C. Because of the limited supply, applicants are urged to select only a few numbers, choosing those which are of special interest to them. Residents of foreign countries should apply to the Superintendent of Documents, Government Printing Office, Washington, D. C., who has these bulletins for sale. Price 5 cents each to Canada, Cuba, and Mexico; 6 cents to other foreign countries. The bulletins entitled "Experiment Station Work" give briefly the results of experiments performed by the State experiment stations.

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332. Nuts and Their Uses as Food.
333. Cotton Wilt.
334. Experiment Station Work—XLVIII.
335. Harmful and Beneficial Mammals of the Arid Interior.
337. Cropping Systems for New England Dairy Farms.
338. Macadam Roads.
339. Alfalfa.
341. The Basket Willow.
342. Experiment Station Work—XLIX.
343. The Cultivation of Tobacco in Kentucky and Tennessee.
344. The Boll Weevil Problem, with Special Reference to Means of Reducing Damage.
345. Some Common Disinfectants.
346. The Computation of Rations for Farm Animals by the Use of Energy Values.
347. The Repair of Farm Equipment.
348. Bacteria in Milk.
349. The Dairy Industry in the South.
350. The Dehorning of Cattle.
351. The Tuberculin Test of Cattle for Tuberculosis.
352. The Nevada Mouse Plague of 1907–8.
353. Experiment Station Work—L.
354. Onion Culture.
355. A Successful Poultry and Dairy Farm.
356. Peanuts.
357. Methods of Poultry Management at the Maine Agricultural Experiment Station.
358. A Primer of Forestry. Part II: Practical Forestry.
359. Canning Vegetables in the Home.
360. Experiment Station Work—LI.
361. Meadow Fescue: Its Culture and Uses.
362. Conditions Affecting the Value of Market Hay.
363. The Use of Milk as Food.
364. A Profitable Cotton Farm.
365. Farm Management in Northern Potato-growing Sections.
366. Experiment Station Work—LII.
367. Lightning and Lightning Conductors.
368. The Eradication of Bindweed, or Wild Morning-glory
369. How to Destroy Rats.
370. Replanning a Farm for Profit.
371. Drainage of Irrigated Lands.
372. Soy Beans.
373. Irrigation of Alfalfa.
374. Experiment Station Work—LIII.
375. Care of Food in the Home.
376. Game Laws for 1909.
377. Harmfulness of Headache Mixtures.
378. Methods of Exterminating the Texas-fever Tick.
379. Hog Cholera.
380. The Loco-weed Disease.
381. Experiment Station Work—LIV.
382. The Adulteration of Forage-plant Seeds.
383. How to Destroy English Sparrows.
384. Experiment Station Work—LV.
385. Boys' and Girls' Agricultural Clubs.
386. Potato Culture on Irrigated Farms of the West.
387. The Preservative Treatment of Farm Timbers.
388. Experiment Station Work—LVI.
389. Bread and Bread Making.
390. Pheasant Raising in the United States.
391. Economical Use of Meat in the Home.
392. Irrigation of Sugar Beets.
393. Habit-forming Agents.
394. The Use of Windmills in Irrigation in the Semiarid West.
395. Sixty-day and Kherson Oats.
396. The Muskrat.